The NASA Severe Thunderstorm Observations and Regional Modeling (NASA STORM) Project

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Motivation

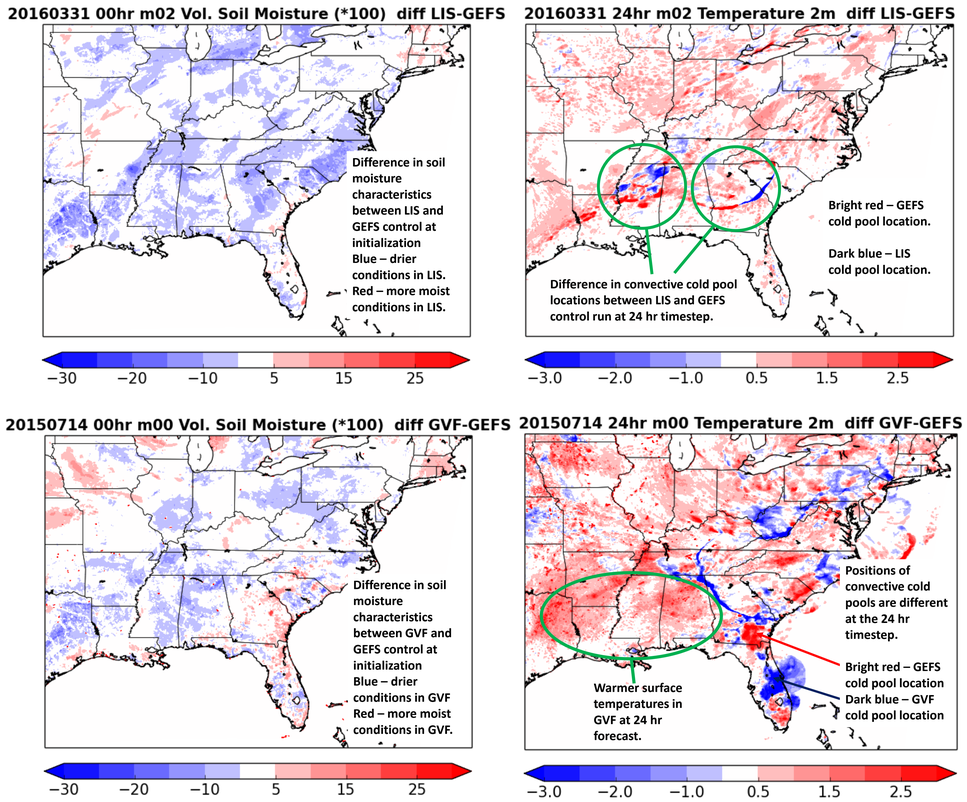
The NASA Severe Storm Thunderstorm Observations and Regional Modeling (NASA STORM) project enhanced NASA's severe weather research capabilities, building upon existing Earth Science expertise at NASA Marshall Space Flight Center (MSFC). During this project, MSFC extended NASA's ground-based lightning detection capacity to include a readily deployable lightning mapping array (LMA). NASA STORM also enabled NASA's Short-term Prediction and Research Transition (SPoRT) to add convection allowing ensemble modeling to its portfolio of regional numerical weather prediction (NWP) capabilities. As a part of NASA STORM, MSFC developed new open-source capabilities for analyzing and displaying weather radar observations integrated from both research and operational networks. These accomplishments enabled by NASA STORM are a step towards enhancing NASA's capabilities for studying severe weather and positions them for any future NASA related severe storm field campaigns.

Ensemble Modeling using NASA Unified WRF (NU WRF)

The focus of the Ensemble modeling effort is to develop a framework to create 0-30 hour forecasts within the NU-WRF to understand the performance on a new high end modeling cluster at MSFC. The focus for this project was on how the underlying land surface affects the timing and location of convective development in two severe weather events in the Southeast US.

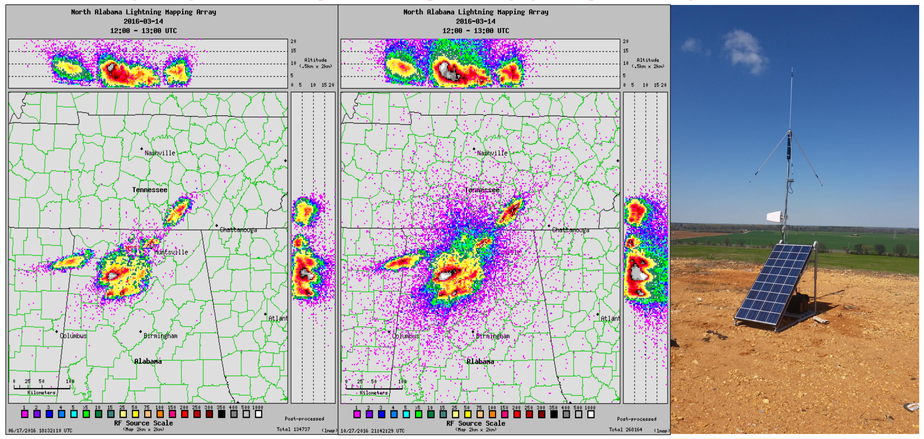
Ensemble Setup:

- 6 member GEFS ensemble, random choosing out of 20 possible members.
- 3 configurations for each GEFS ensemble member, varying the land surface, totaling 18 different model runs. The same 6 GEFS members are used for each of the 3 configurations.
- Land surface configurations:
  - Basic GEFS parameterization (control)
  - NASA Land Information System (LIS) parameterization
  - NASA LIS + Green Vegetation Fraction (GVF)
- 3 km spatial resolution, 56 levels, 18 second time step.
- 9 nodes, 252 processors, 3.1 hrs per member. The full 26 node configuration lowers this to 1.03 hrs per member.
- Goddard 4 microphysics and radiation physics, MYJ boundary conditions, Noah Land surface scheme.



Altering the soil moisture and vegetation characteristics increases the spread of solutions for the 30 hour forecast. This spread impacts 2 m temperature values and thunderstorm cold pool locations.

Deployable Lightning Mapping Array Sensors

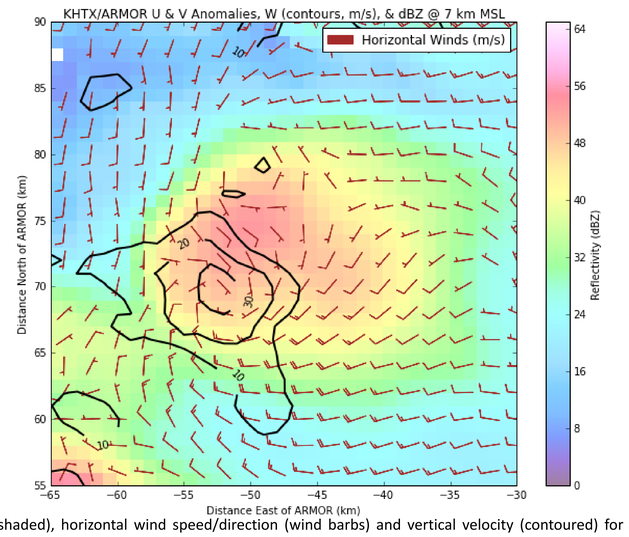


NALMA only | **NALMA plus 4 deployable stations** | **Deployable station at landfill site.**

1) 5 LMA Sensors have been developed for stand alone data collection using solar power and cell phone modems.
2) Integration of data from sensors operating at different VHF channels was also achieved in collaboration with New Mexico Tech and Texas Tech.
3) To date, all 5 deployable stations are still deployed and enhancing the detection of lightning over North Alabama. These stations will remain operational through the spring and summer of 2017.

Open Source Radar Tool Development

Open source radar tool development using python focused on compositing of radar measurements from multiple frequencies with output in a GIS format and developing multi-Doppler wind syntheses. The benefits of these capabilities are:



Reflectivity (shaded), horizontal wind speed/direction (wind barbs) and vertical velocity (contoured) for a supercell thunderstorm on 10 April 2009 using the WSR-88D at Hytop, AL and the UAH Advanced Radar for Meteorological and Operational Research.

1) The GIS-enabled compositing procedure improved rainfall rate estimates, hydrometeor id, and reduced noise observed in individual radar data.
2) Enables end users to ingest, correct, and grid their radar data using Py-ART, and then pass the radar volumes to MultiDop to synthesize, analyze, and display the 3D winds.

https://github.com/nasa/DualPol, NASA New Technology Report (NTR) e-NTR #1474647788